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Kim et al.

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(54) **FOLDABLE SCOOTER**

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Related U.S. Application Data

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(51) **Int. Cl.**

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B62K 17/00	(2006.01)
B62K 11/00	(2006.01)
B62K 3/02	(2006.01)
B62K 25/00	(2006.01)

(52) **U.S. Cl.**

CPC ***B62K 15/006*** (2013.01); ***B62K 3/02*** (2013.01); ***B62K 11/00*** (2013.01); ***B62K 15/008*** (2013.01); ***B62K 17/00*** (2013.01); ***B62K 25/005*** (2013.01)

(58) **Field of Classification Search**

USPC 280/287, 278

See application file for complete search history.

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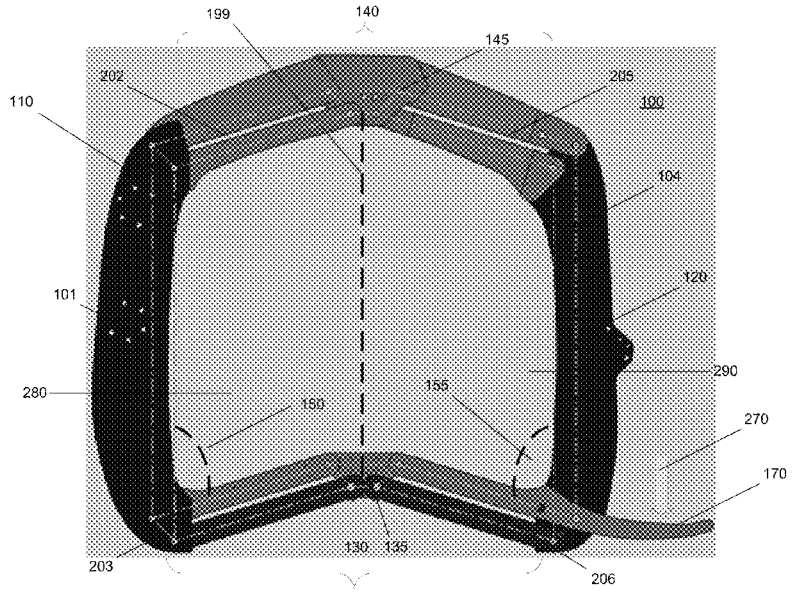
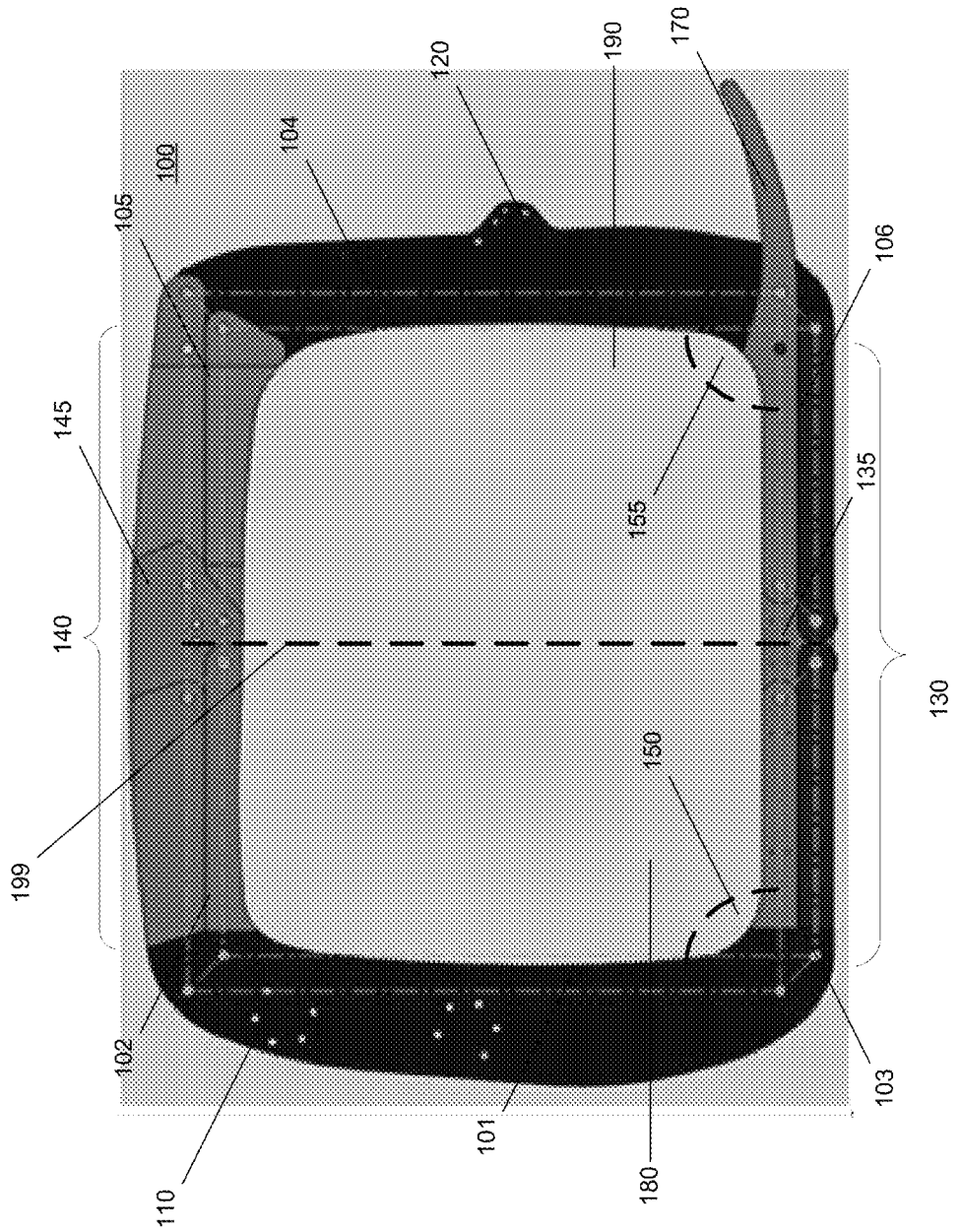
(57) **ABSTRACT**

Embodiments of the invention describe a quadrilateral frame to be utilized by a two-wheeled vehicle. The quadrilateral frame may include front and rear vertical assemblies, top and bottom collapsible horizontal assemblies, the horizontal assemblies to collapse vertically. By collapsing the horizontal assemblies of the quadrilateral frame, it is to be understood that the space occupied by the vehicle when it is not in use is significantly reduced.

11 Claims, 9 Drawing Sheets




120
190
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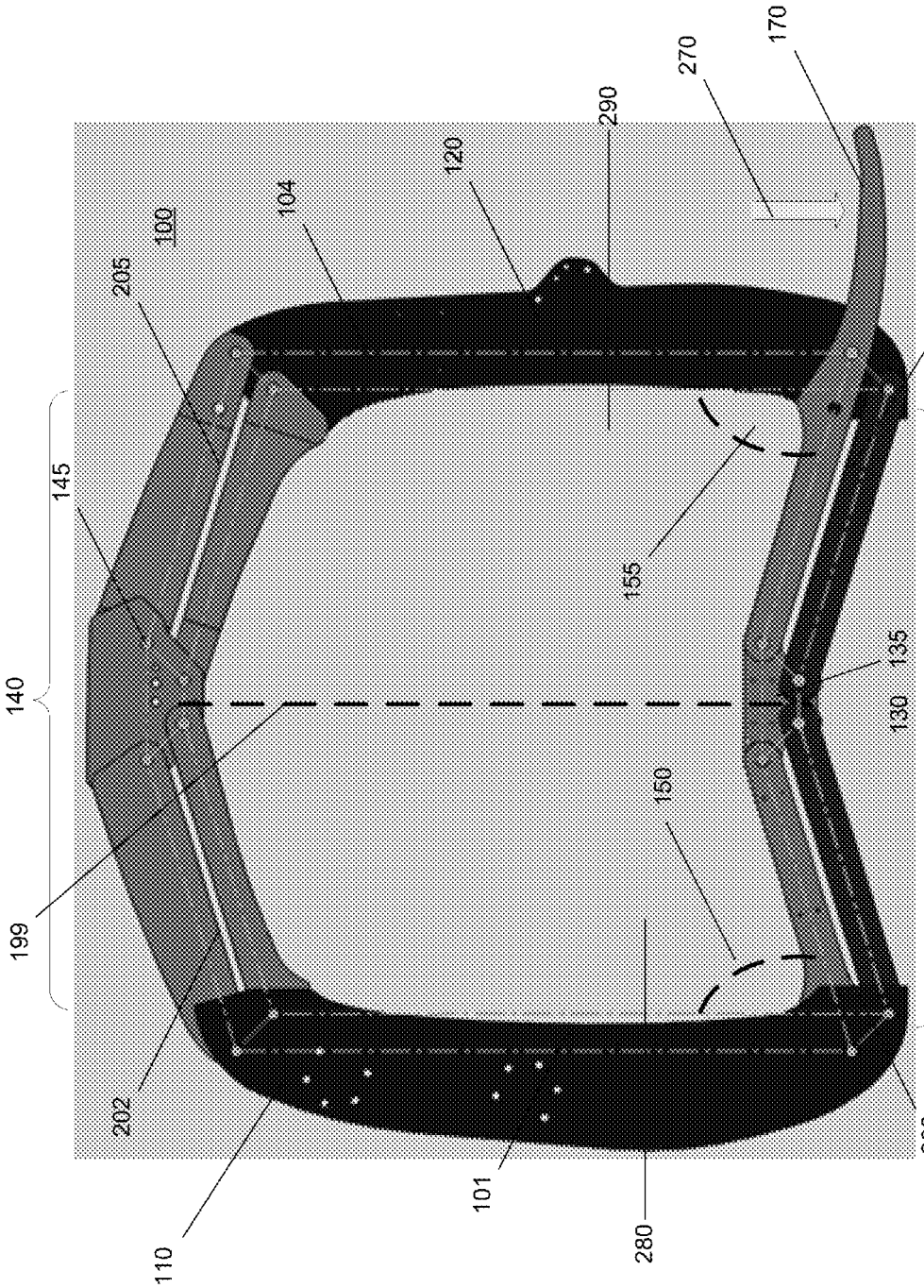
180
110

FIG. 1


100
104
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290
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205
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145
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199
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110
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FIG. 2

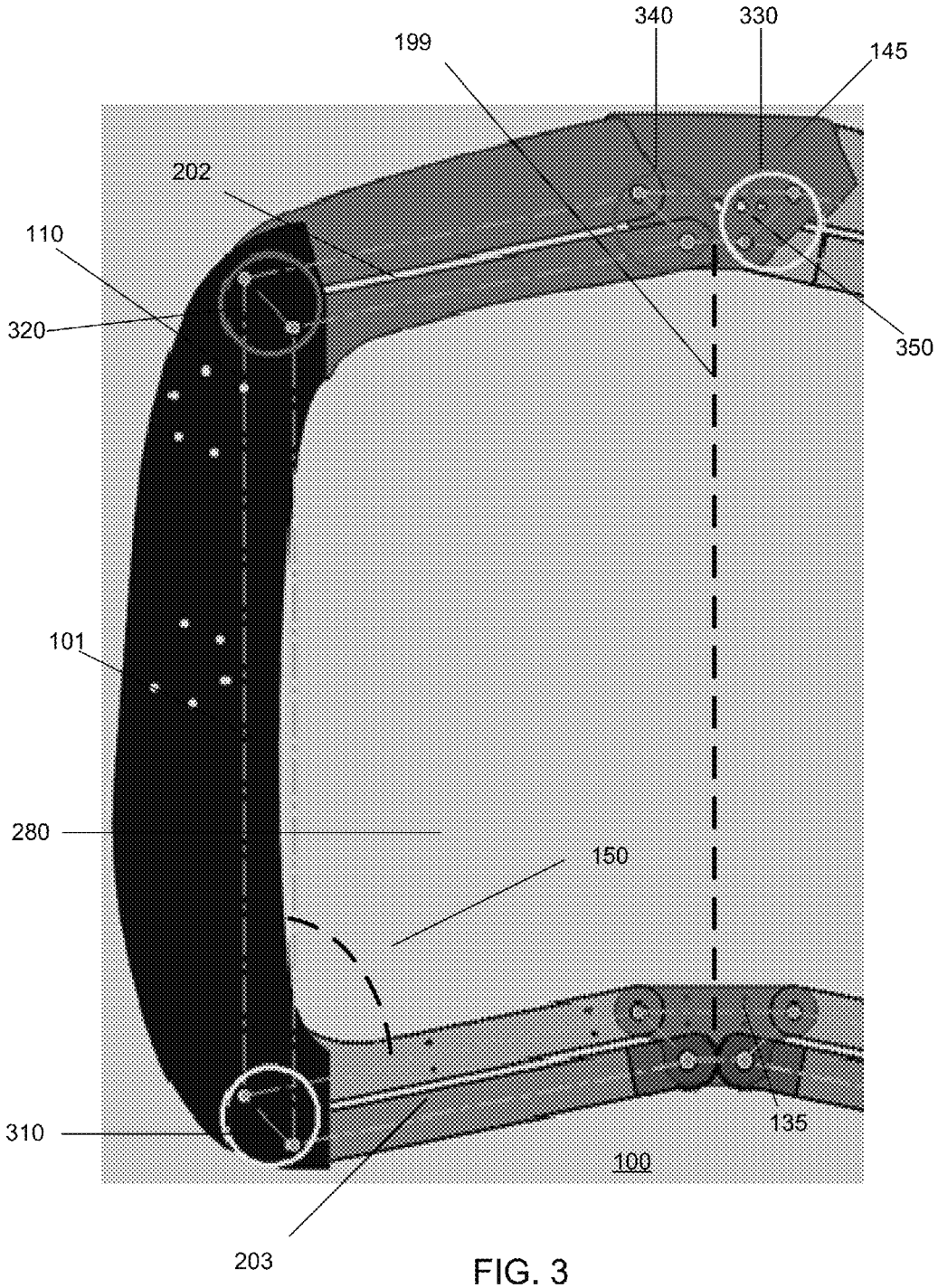
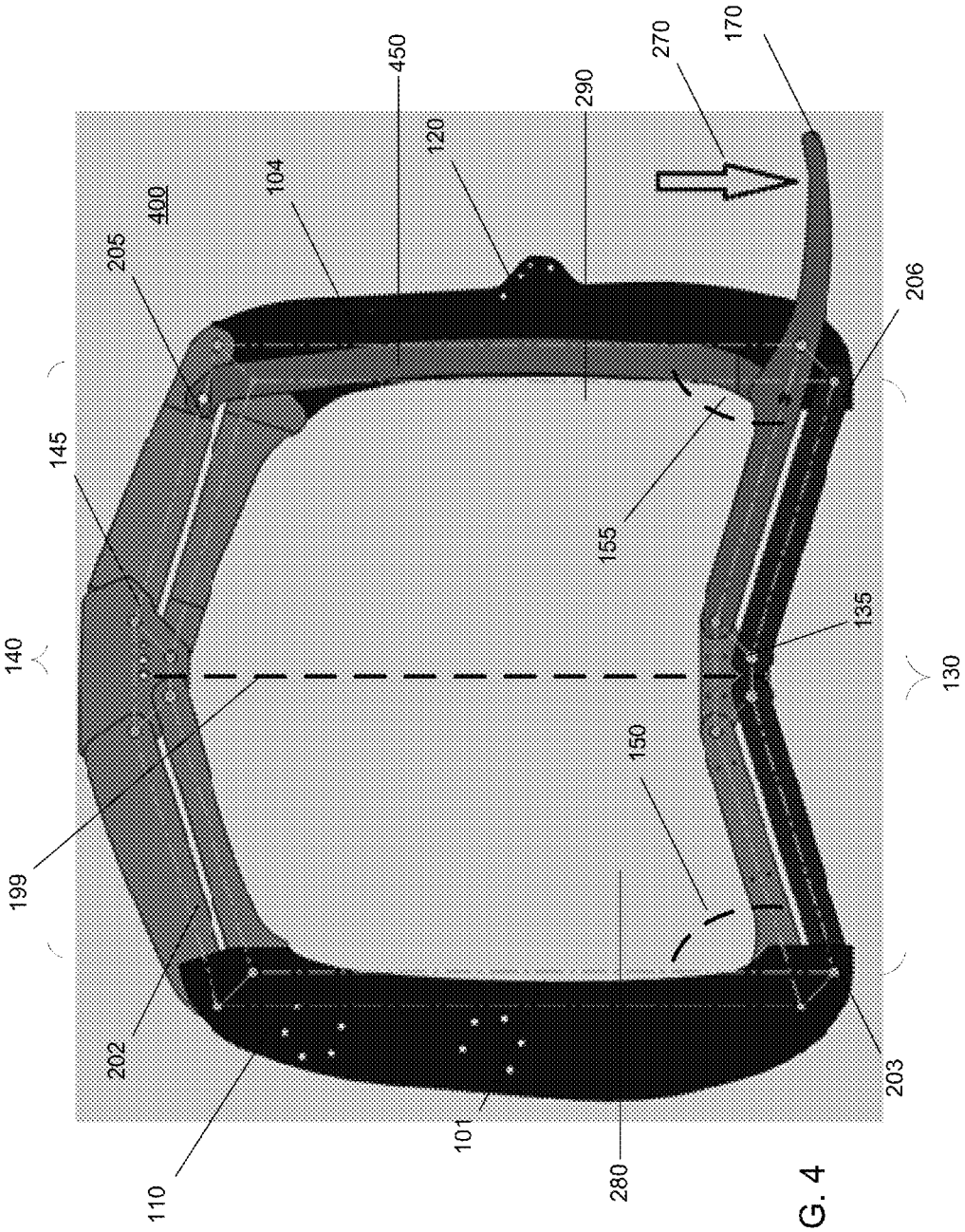


FIG. 3


450
290
270
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110
101
280

FIG. 4

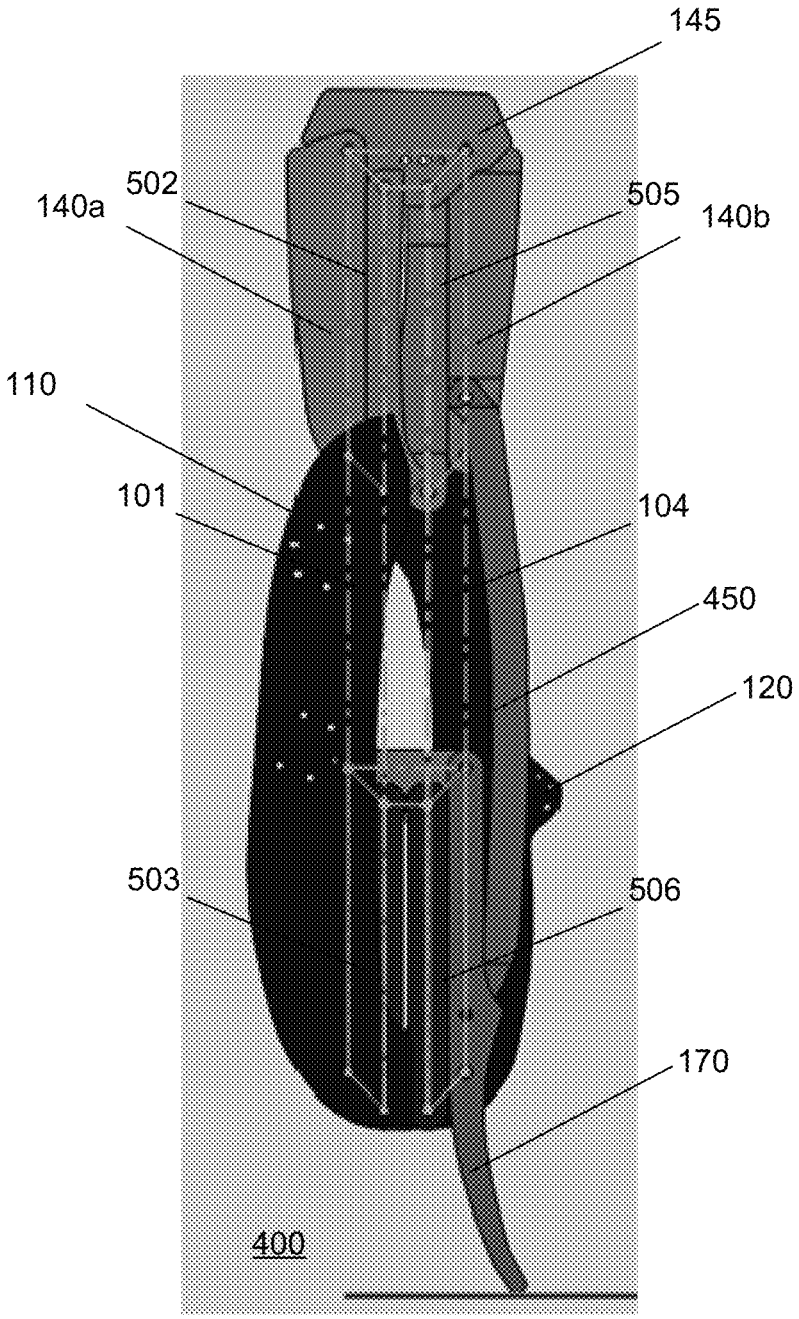

FIG. 5

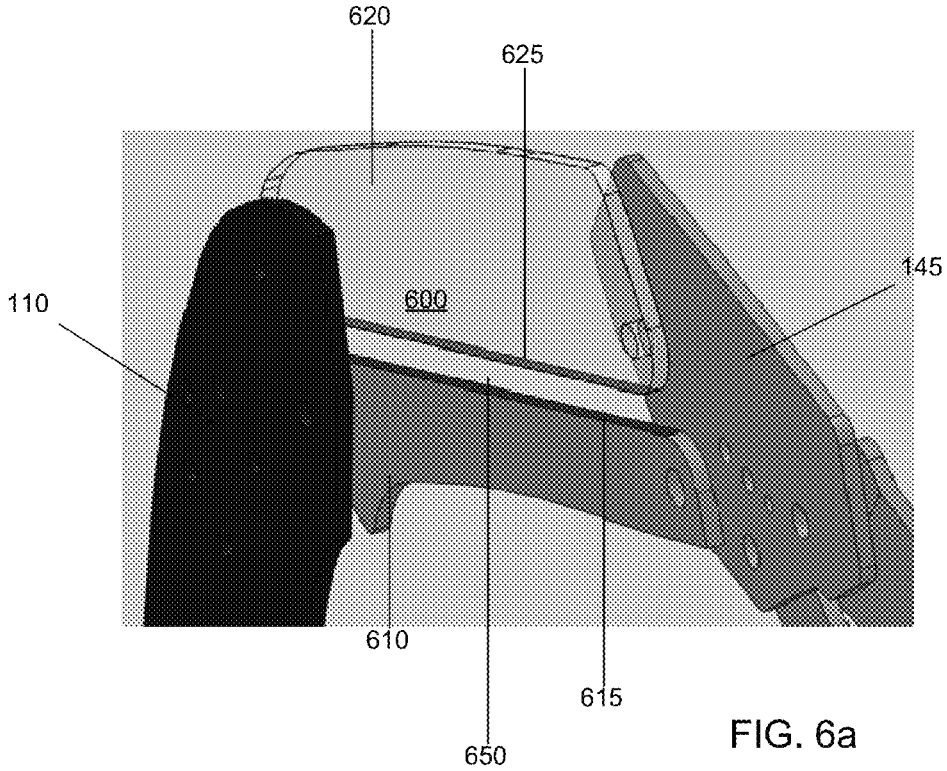

FIG. 6a

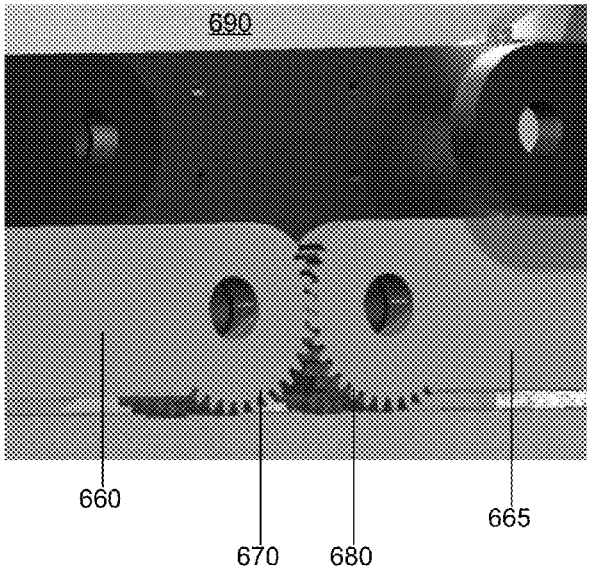

FIG. 6b

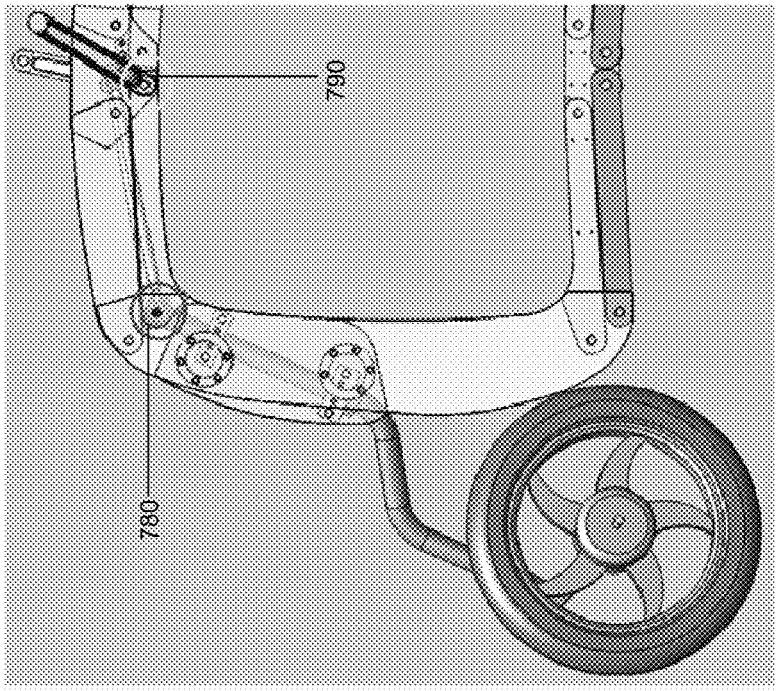

FIG. 7b

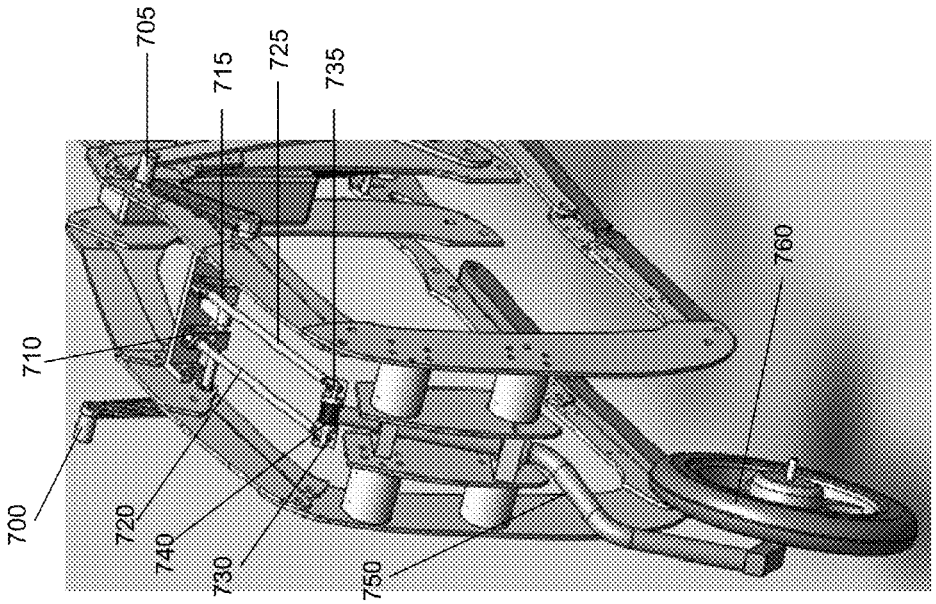

FIG. 7a

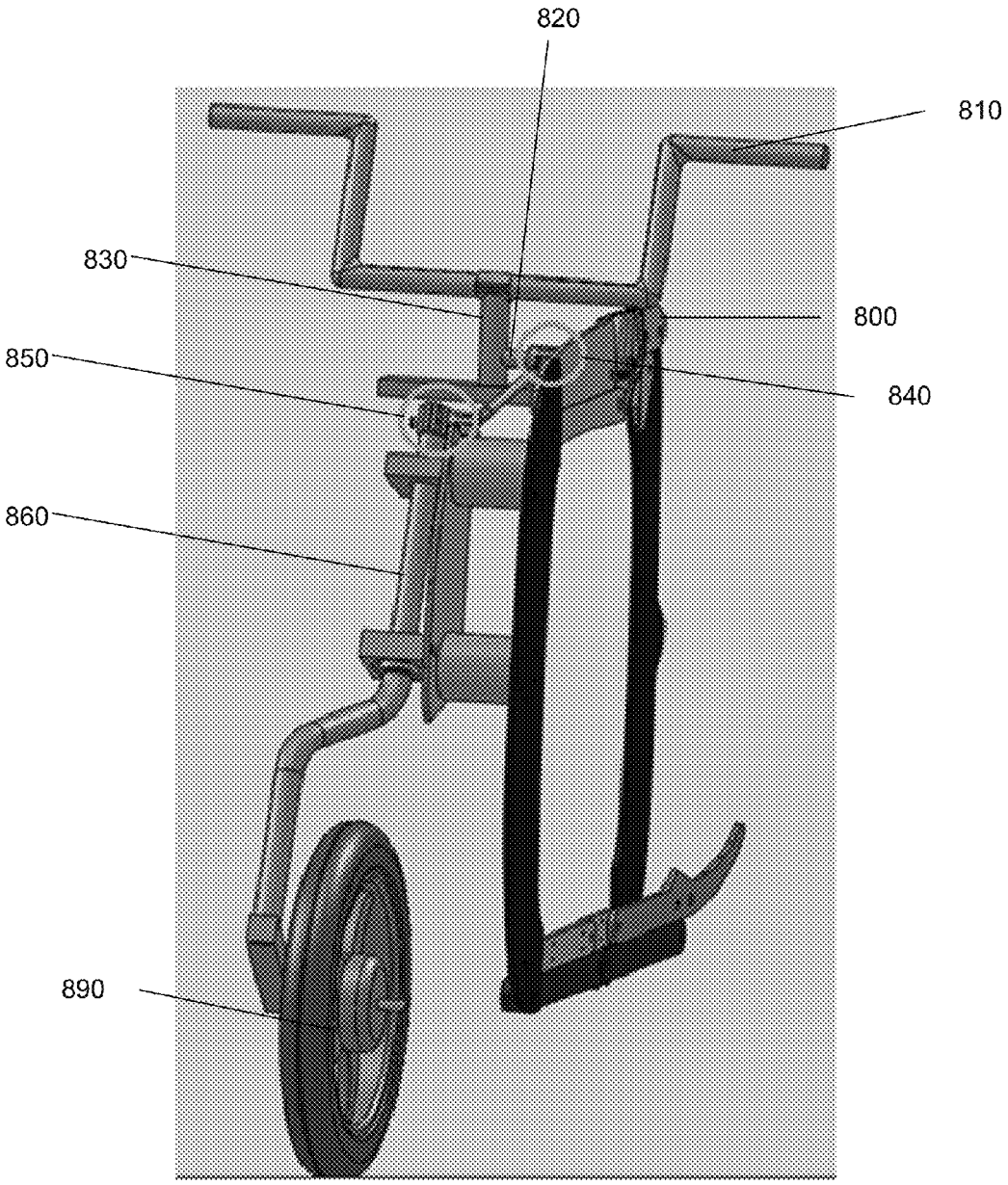

FIG. 8

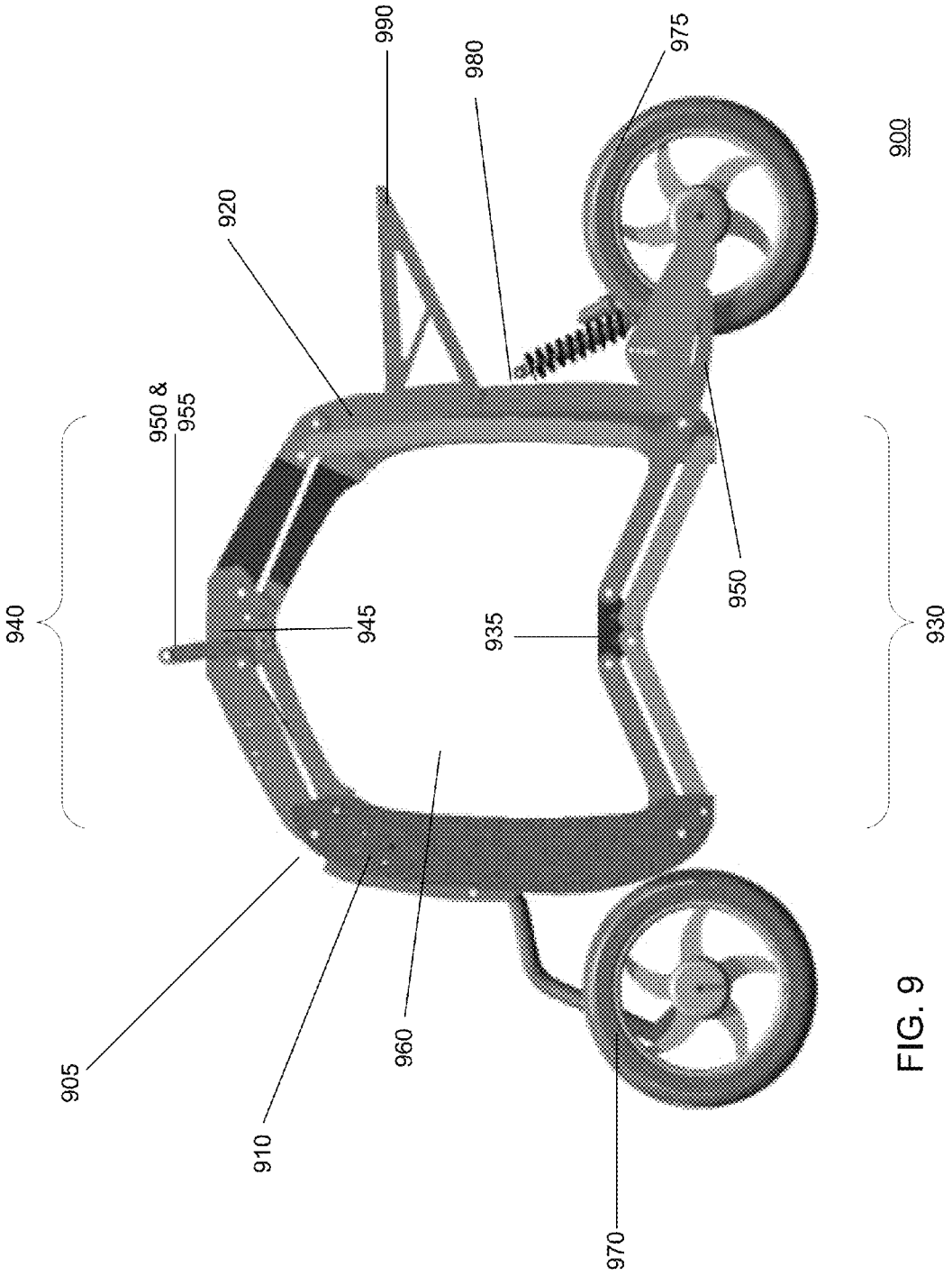

FIG. 9

FOLDABLE SCOOTER

RELATED APPLICATION

This Application is a Continuation of, and claims the benefit of, U.S. patent application Ser. No. 12/893,981, filed Sep. 29, 2010.

FIELD OF THE INVENTION

Embodiments of the invention generally pertain to transportation vehicles, and more particularly to collapsible frames for two-wheeled vehicles.

BACKGROUND

Motorcycles and scooters are an attractive alternative over automobiles because of their lower cost of ownership and reduced energy consumption. One of the limitations a motorcycle or scooter has is the space occupied by the vehicle when it is not in use.

While folding bicycles are known in the art, their foldable frames are not suitable for motorized cycles, as bicycle frames are not subject to the same amounts of force and torque. Collapsible stand-up scooters are known in the art, but these solutions simply allow a user to collapse the handlebar assembly of the scooter. These solutions do not effectively reduce the space of the scooter when it is not in use.

BRIEF DESCRIPTION OF THE DRAWINGS

The following description includes discussion of figures having illustrations given by way of example of implementations of embodiments of the invention. The drawings should be understood by way of example, and not by way of limitation. As used herein, references to one or more "embodiments" are to be understood as describing a particular feature, structure, or characteristic included in at least one implementation of the invention. Thus, phrases such as "in one embodiment" or "in an alternate embodiment" appearing herein describe various embodiments and implementations of the invention, and do not necessarily all refer to the same embodiment. However, they are also not necessarily mutually exclusive.

FIG. **1** illustrates a vehicle frame according to an embodiment of the invention.

FIG. **2** is an illustration of a vehicle frame partially folded or collapsed according to an embodiment of the invention.

FIG. **3** is an illustration of individual virtual sub-linkages according to an embodiment of the invention.

FIG. **4** is an illustration of a vehicle frame partially folded or collapsed according to an embodiment of the invention.

FIG. **5** is an illustration of a collapsed vehicle frame according to an embodiment of the invention.

FIG. **6***a* is an illustration of a parallel linkage subsystem according to an embodiment of the invention.

FIG. **6***b* is an illustration of a geared linkage subsystem according to an embodiment of the invention.

FIGS. **7***a* & **7***b* are illustrations of a steering system according to an embodiment of the invention.

FIG. **8** illustrates a steering system according to an embodiment of the invention.

FIG. **9** illustrates a vehicle according to an embodiment of the invention.

Descriptions of certain details and implementations follow, including a description of the figures, which may depict some or all of the embodiments described below, as well as a discussion of other potential embodiments or implementations of the inventive concepts presented herein. An overview of embodiments of the invention is provided below, followed by a more detailed description with reference to the drawings.

DESCRIPTION

Embodiments of the invention describe a quadrilateral frame to be utilized by a two-wheeled vehicle. The quadrilateral frame may include front and rear vertical assemblies and top and bottom collapsible horizontal assemblies, the horizontal assemblies to collapse vertically. By collapsing the horizontal assemblies of the quadrilateral frame, it is to be understood that the space occupied by the vehicle is significantly reduced.

FIG. **1** illustrates a vehicle frame according to an embodiment of the invention. In this embodiment, quadrilateral frame **100** is fully extended (as opposed to partially or fully collapsed, described below). In this embodiment, quadrilateral frame **100** is a relatively square frame with relatively vertical assemblies **110** and **120**, and relatively horizontal assemblies **130** and **140**. It is to be understood that reference to "vertical" and "horizontal" assemblies is merely to identify a first and second set of opposite assemblies. In other embodiments, the orientation and shape of quadrilateral frame **100** may be such that each assembly is neither relatively "horizontal" nor relatively "vertical." Thus, in other embodiments, the frame may be any quadrilateral shape with a first and second set of opposing (e.g., facing and parallel) assemblies.

Horizontal assemblies **130** and **140** each include center bracket portions **135** and **145**, respectively. In this embodiment, center bracket portions **135** and **145** are each at the mid-point of their respective horizontal assemblies, and both allow each assembly to collapse upward as described below.

Frame **100** further includes lever **170**. In this embodiment, applying downward force on lever **170** at least partially enables the collapse of horizontal assemblies **130** and **140** as described below.

Frame **100** defined and constrained by a series of arranged virtual parallelogram sub-linkages, specifically linkages **101-106**. Each quadrant of frame **100** contains one of virtual parallelogram sub-linkages **101-106**. These sub-linkages are related through vertical assemblies **110** and **120** and center brackets **135** and **145**. In this embodiment, each vertical assembly provides a fixed relation parallelogram (i.e., virtual parallelogram sub-linkages **101** and **104**).

As described below, frame **100** folds via two linked parallelograms **180** and **190**, which share common virtual leg or linkage **199** (i.e., parallelogram **180** is formed by virtual parallelogram linkages **101-103** and virtual leg **199**, while parallelogram **190** is formed by virtual parallelogram linkages **104-106** and virtual leg **199**).

In one embodiment, parallelograms **180** and **190** behave with a mirrored relationship due to a geared sub-assembly included in horizontal assembly **130** as described below. The geared sub-assembly causes angles **150** (formed by assemblies **110** and **130**) and **155** (formed by assemblies **120** and **130**) to remain equal to each other in all frame states (i.e., any state between and including extended and collapsed).

In this embodiment, while frame **100** is in the neutral position (i.e., extended), virtual sub-linkages **101-106** are mirrored over the vertical axis (e.g., virtual leg **199**), but not necessarily the horizontal axis—i.e., virtual sub-linkage **101** is mirrored with virtual sub-linkage **104**, virtual sub-linkage **102** is mirrored with virtual sub-linkage **105** and virtual sub-linkage **103** is mirrored with virtual sub-linkage **106**.

Said virtual sub-linkages are, however, copied and patterned equidistant from the horizontal axis. It is important to note in this embodiment the smallest effective linkages are defined by the connection of two opposite corners of a square (or the larger leg of a 45-45-90 triangle). In alternative embodiments however, the folding mechanism may be replicated with effective sub-linkages defined by opposite corners of any quadrilateral.

FIG. **2** is an illustration of a vehicle frame partially folded or collapsed according to an embodiment of the invention. In this embodiment, the partial collapse of frame **100** is initiated at least in part by downward force **270** applied to lever **170**.

In this illustration, it is clear that mirrored linkage geometry (i.e., parallelograms **280** and **290**) causes vertical assemblies **110** and **120** to remain parallel at all times. In this state of partial collapse, along with parallelograms **280** and **290**, all virtual sub-linkages except sub-linkages **101** and **104** have changed (i.e., virtual sub-linkages **202**, **203**, **205** and **206**) with respect to FIG. **1**.

Parallelograms **280** and **290** behave with a mirrored relationship due to the geared sub-assembly included in horizontal assembly **130** as described below. As discussed above, the gear assembly causes angles **150** (formed by assemblies **110** and **130**) and **155** (formed by assemblies **120** and **130**) to remain equal to each other at all times.

FIG. **3** is an illustration of individual virtual sub-linkages according to an embodiment of the invention. In this embodiment, small virtual linkages **310** and **330** have direct and fixed relationships with two other small virtual linkages, **320** and **340**, respectively. Thus, virtual sub-linkages **202** and **203** are equal, as are virtual sub-linkage **101** and virtual leg **199**, thereby creating parallelogram **280**.

In this embodiment, small linkage **330** is solidly linked to its mirrored counterpart, small linkage **340**, thereby creating anchored constant isosceles trapezoid **350**. Therefore virtual linkage **202** has a constant mirrored relationship with virtual linkage **205** (as seen in FIGS. **1-2**).

Furthermore, small linkages **310** and **320** are the same length, parallel and have fixed positions due to vertical assembly **110** being of fixed length and position. Thus, virtual linkage **101** is constant throughout the various stages of frame **100** between extended and collapsed.

FIG. **4** is an illustration of a vehicle frame partially folded or collapsed according to an embodiment of the invention. In this embodiment, frame **400** is similar to partially collapsed frame **100** as described in FIG. **2** (thus, including the same virtual linkages). In this embodiment, additional vertical assembly **450** is coupled to horizontal assemblies **130** and **140** to provide a mechanical advantage for assisted folding. By applying downward force **270** to lever **170**, force is applied to both horizontal assemblies **130** and **140**, thereby adding mechanical advantages to the folding mechanism compared to the embodiments described in FIGS. **1-2**.

FIG. **5** is an illustration of a collapsed vehicle frame according to an embodiment of the invention. In this embodiment, frame **400** is completely folded because horizontal assemblies **130** (not shown) and **140** (as shown in parts **140***a* and **140***b*) are completely folded. Similar to the previously described vehicle frames, virtual sub-linkage **502** is mirrored with virtual sub-linkage **505**, while virtual sub-linkage **503** is mirrored with virtual sub-linkage **506**.

FIG. **6***a* is an illustration of a parallel linkage subsystem according to an embodiment of the invention. Parallelogram linkage subsystem **600** may be included in any horizontal assembly described above. Subsystem **600** provides a mechanical stop to prevent the entire frame (e.g., frames **100** and **400** as described above) from folding in the wrong direction and "over-folding."

In one embodiment, face **625** of horizontal subcomponent **620** meets or connects with face **615** of counterpart horizontal subcomponent **610** when the respective frame is in the neutral (i.e., unfolded) position. It is to be understood that this embodiment prevents center bracket **145** from moving to a lower than desired position (i.e., the embodiment prevents the frame from folding in the wrong direction). It is to be understood that the connection of the horizontal subcomponents in the completely folded position (as shown in FIG. **5**, elements **140***a* and **140***b*) similarly prevents "over-folding" of the respective frame. In some embodiments, the horizontal subcomponents of a vehicle are further reinforced by a locking mechanism to prevent undesirable folding.

FIG. **6***b* is an illustration of a geared linkage subsystem according to an embodiment of the invention. Geared linkage subsystem **690** may be included in any horizontal assembly described above. In this embodiment, each of horizontal subcomponents **660** and **665** are geared assemblies designed to maintain constant virtual sub-linkages as described above. Said geared assemblies prevent unequal angles of folding (e.g., angles **150** and **155** in FIGS. **1-2**) for the respective horizontal assembly.

FIG. **7***a* is an illustration of a steering system according to an embodiment of the invention. In one embodiment, a collapsible frame includes right handlebar **700** and left handlebar **705**. In this embodiment, applying forward force on right handlebar **700** causes front wheel **760** to rotate counterclockwise (from the riders perspective) or turn the vehicle left; applying forward force on left handlebar **705** causes front wheel **770** to rotate clockwise (from the riders perspective) or turn the vehicle right.

The steering functionality described above is achieved via a directed link from handlebars **700** and **705** to respective small brackets **710** and **715** respectively. Straight linkages **720** and **725** each include pivots on their ends and are each coupled to mechanical advantage brackets **710** and **715** respectively. The straight linkages are further coupled to devises **730** and **735**, respectively. The clevises are each further coupled to pivot block **740**. This block is further coupled to the fork **750** (which is coupled to front wheel **760**). Therefore, steering torque is transmitted as follows: handlebars (**700**, **705**) to mechanical advantage brackets (**710**, **715**) to devises (**720**, **725**) to pivot block **740** to fork **750**.

The geometry of the steering system described above, along with the position of handlebars **700** and **705**, allow the steering components to remain uninterrupted as the frame undergoes folding and unfolding. As shown in FIG. **7***b*, the center of pivot block **740** (defined by the intersection of clevises' **720** and **725** rotation axes and the connect axis of fork **750**) is aligned with pivot point **780** of the folding frame. Handlebars **700** and **705** are connected to the steering system at pivot point **790** that remains at a constant distance from pivot point **780** in all frames states (i.e., any states between and including folded and unfolded). Therefore, a trianglular relationship is created between the center of clevis pivot block **740**, the lower pivot axis of mechanical advantage bracket **710** and the upper pivot axis of mechanical advantage bracket **710** (and similarly, a trianglular relationship is created between the center of clevis pivot block **740**, the lower pivot axis of mechanical advantage bracket **715** and the upper pivot axis of mechanical advantage bracket **715**). This triangular relationship is constant during all frame states, thus the steering system described above is functional and geometrically consistent with the frame in all frame states. This geometry

may also cause front wheel **760** to align itself in the neutral position when folding is initiated.

FIG. **8** illustrates a steering system according to an embodiment of the invention. In this embodiment, the steering system includes handlebars **810** to turn front wheel **890**. Handlebars **810** may be coupled to horizontal linkage **820** of collapsible assembly **800** via mounting post **830**. Said mounting post may pivot with handlebars **810** and is further coupled to first custom multi-pivot connector **840**. Said multi-pivot connector may be further coupled to a second multi-pivot connector **850**, which is coupled to steering column **860**. Thus, force applied to handlebars **810** is translated to front wheel **890** via the components described above. It is to be understood that while assembly **800** folds (along with the opposing horizontal assembly, as described above), handlebars **810** remain constantly related to the pivoting horizontal member, thereby allowing for uninterrupted frame folding.

FIG. **9** illustrates a vehicle according to an embodiment of the invention. In this embodiment, vehicle **900** includes quadrilateral frame **905**, shown here in a partially folded state (as opposed to fully collapsed, or fully extended as described above). In this embodiment, quadrilateral frame **905** includes vertical assemblies **910** and **920**, and horizontal assemblies **930** and **940**. In this embodiment, quadrilateral frame **905** has a rectangular shape when fully extended, with horizontal frames **930** and **940** each longer than vertical assemblies **910** and **920**.

Horizontal assemblies **930** and **940** each include brackets **935** and **945**, respectively, to enable the assemblies to fold (i.e., collapse). In this embodiment, brackets **935** and **945** are each at the mid-point of their respective horizontal assemblies, and both allow each assembly to collapse upward. In some embodiments, the vehicle **900** further includes a locking mechanism to help maintain frame **905** in an extended or folded state.

Vehicle **900** also includes lever **950**. In this embodiment, applying downward force on the lever at least partially enables the collapse of horizontal assemblies **930** and **940** (the collapse of the assemblies may be further enabled by a user applying an upward force to handlebars **950** and **955**). In one embodiment, vehicle **900** includes a second lever on the opposite side of lever **950**, which may work independently or may be coupled with lever **950**.

Center space or void **960** is eliminated when vehicle **900** is folded completely as described above (e.g., in FIG. **5**). In some embodiments, the horizontal and vertical assemblies of frame **905** may be of a certain length such that void **960** may accommodate appropriate sized cargo.

Vehicle **900** may further include front wheel **970** and rear wheel **975**, each coupled to frame **910**. In this embodiment, front wheel **970** is coupled to vertical assembly **910** and rear wheel **975** is coupled to both vertical assembly **920** and horizontal assembly **930**. It is to be understood that in other embodiments, front wheel **970** and rear wheel **975** may be coupled to different parts and locations of vehicle frame **905**. In this embodiment, front wheel **970** and rear wheel **975** support vehicle **900** in all vehicle states. In other embodiments, after approximately a 90 degree rotation, lever **950** is able to act as a center stand for vehicle **900** (i.e., rear wheel **975** is raised off the ground).

Vehicle **900** further includes motor **980** positioned below seat **990** to drive rear wheel **975**. In one embodiment, motor **980** is included within vertical assembly **920** so as not to affect the movement (i.e., collapsibility) of frame **905**.

Those skilled in the art will recognize that numerous modifications and changes may be made to the described embodiments without departing from the scope of the claimed invention. It will, of course, be understood that modifications of the invention, in its various aspects, will be apparent to those skilled in the art, some being apparent only after study, others being matters of routine mechanical, chemical and electronic design. No single feature, function or property of the preferred embodiment is essential. Other embodiments are possible, their specific designs depending upon the particular application. As such, the scope of the invention should not be limited by the particular embodiments herein described but should be defined only by the appended claims and equivalents thereof.

Methods and processes, although shown in a particular sequence or order, unless otherwise specified, the order of the actions may be modified. Thus, the methods and processes described above should be understood only as examples, and may be performed in a different order, and some actions may be performed in parallel. Additionally, one or more actions may be omitted in various embodiments of the invention; thus, not all actions are required in every implementation. Other process flows are possible.

The invention claimed is:

1. An apparatus comprising:

a quadrilateral frame comprising a foldable frame and including:

a first vertical assembly and a second vertical assembly; and

a first collapsible horizontal assembly and a second collapsible horizontal assembly, the first collapsible horizontal assembly positioned above the second collapsible horizontal assembly, both collapsible horizontal assemblies to collapse vertically and in a same direction;

a front wheel and a rear wheel, both wheels coupled to the quadrilateral frame; and

a lever coupled to the second collapsible horizontal assembly of the quadrilateral frame, the second collapsible horizontal assembly to collapse in response to a force applied to the lever;

wherein the front wheel and the rear wheel are positioned to be capable of at least partially supporting the apparatus when the first collapsible horizontal assembly and second collapsible horizontal assembly of the quadrilateral frame are in a collapsed state.

2. The apparatus of claim **1**, wherein the first collapsible horizontal assembly and the second collapsible horizontal assembly of the quadrilateral frame to collapse vertically and away from the front wheel and the rear wheel.

3. The apparatus of claim **1**, wherein at least one of the first collapsible assembly or the second collapsible horizontal assembly of the quadrilateral frame comprises:

a first geared sub-assembly coupled to the first vertical assembly; and

a second geared sub-assembly coupled to the first geared sub-assembly and the second vertical assembly, wherein the first geared sub-assembly and the second geared sub-assembly are geared to control a collapse for the respective first or second collapsible horizontal assembly.

4. The apparatus of claim **1**, wherein the front wheel is placed in front of the rear wheel when the quadrilateral frame is a folded state and when the quadrilateral frame is in an unfolded state, and the apparatus further comprises:

a steering system included in at least the first collapsible horizontal assembly and the first vertical assembly of the quadrilateral frame, the steering system able to steer the apparatus when the quadrilateral frame is in the folded state and when the apparatus is in the unfolded state.

5. The apparatus of claim 4, further comprising:

a locking mechanism to lock the quadrilateral frame in at least one of the folded state or the unfolded state.

6. The apparatus of claim 1, wherein the lever comprises a rotatable level for lifting the rear wheel and supporting the quadrilateral frame when the quadrilateral frame is in a folded state.

7. The apparatus of claim 1, further comprising:

a motor included in the second vertical assembly of the quadrilateral frame to drive the rear wheel.

8. A foldable quadrilateral vehicle frame comprising:

a set of opposing non-collapsible assemblies;

a first collapsible assembly coupled to the set of opposing non-collapsible assemblies;

a second collapsible assembly coupled to the set of opposing non-collapsible assemblies and positioned opposite the first collapsible assembly, wherein the first collapsible assembly and the second collapsible assembly to collapse in a same direction; and

a lever coupled to one of the first collapsible assembly or the second collapsible assembly, the respective collapsible assembly to collapse in response to a force applied to the lever.

9. The foldable quadrilateral vehicle frame of claim 8, wherein at least one of the first collapsible assembly or the second collapsible assembly includes:

a first geared sub-assembly coupled to a first assembly of the set of opposing non-collapsible assemblies; and

a second geared sub-assembly coupled to the first geared sub-assembly and a second assembly of the set of opposing non-collapsible assemblies, the sub-assemblies geared to control a collapse for the respective first or second collapsible assembly.

10. The foldable quadrilateral vehicle frame of claim 8, further comprising:

a locking mechanism to lock the foldable quadrilateral vehicle frame in at least one of a folded state or an unfolded state.

11. A foldable quadrilateral vehicle frame comprising:

a set of opposing non-collapsible assemblies;

a first collapsible assembly coupled to the set of opposing non-collapsible assemblies;

a second collapsible assembly coupled to the set of opposing non-collapsible assemblies and positioned opposite the first collapsible assembly, wherein the first collapsible assembly and the second collapsible assembly to collapse in a same direction; and

a lever coupled to one of the first collapsible assembly or the second collapsible assembly, the respective collapsible assembly to collapse in response to a force applied to the lever;

wherein at least one of the first collapsible assembly or the second collapsible assembly includes:

a first geared sub-assembly coupled to a first assembly of the set of opposing non-collapsible assemblies; and

a second geared sub-assembly coupled to the first geared sub-assembly and a second assembly of the set of opposing non-collapsible assemblies, the sub-assemblies geared to control a collapse for the respective first or second collapsible assembly.

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